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Investigating the Role Pore Type and Pore Throat Size Radius in Determining the Flow Units using the Velocity Deviation Log and Core Data in Dorood Oilfield, Fahliyan Formation

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INTRODUCTION

Petrophysical rock type is a part of a reservoir that has similar geological and engineering characteristics [1]. To illustrate the petrophysical characteristics of realistic three-dimensional images, these features must be combined with geological features. Accordingly, the pore size distribution controls the permeability and saturation, which is associated with geological processes. It is important to relate these processes in carbonate rocks to the distribution of pore size, to determine that, which pore types belong to which pores (Interparticle, Interconnected Vuggy and non-connected). Each group of these pores has a different type of distribution size and the interrelation among pores. These parameters are controlled by many of the properties of fluid flow in the reservoir under the influence of geological processes (texture and diagenesis). Therefore, these two parameters are the link between engineering and geological characteristics of the reservoir rock [2]. The determination of reservoir rock types using these parameters is an important method for quantitatively determining the reservoir heterogeneity.

DATA AND STUDY METHOD

Data which used in this study include Sonic, Density, and Neutron logs for five wells (KG17, KG18, KG19, D101P, D103WI) and core data for three wells (KG18, D101, D103). This data includes 509 thin sections in three wells, 978 samples with porosity and permeable analysis, and 194 samples of core mercury injection in two samples (D101, D103). In this Study, three methods including flow zone indicator, Winland and Discrete rock types (DRT) approaches were used to determine the petrophysical rock type. It should be mentioned that pore types and pore size distribution are calculated by the velocity deviation log and Mercury injection curve (MICP) respectively. The thin sections are also used as a part of the actual subsurface reservoir information for calibrating the type and size of the pores.

RESULTS AND DISCUSSION DETERMINATION OF PETROPHYSICAL ROCK TYPE

FLOW ZONE INDICATOR

A flow unit is part of a reservoir that is continuously and vertically connected and has similar properties of porosity and permeability [3]. These units are traceable and predictable and with the rest of the reservoir volume, in terms of geological and petrophysical properties affecting the flow of fluid, is constant in each unit [4]. These units are traceable and predictable, and with the rest of the reservoir volume, the geological and petrophysical properties affecting the flow of fluid are similar in each unit [4].

WINLAND METHOD

There is an empirical relationship among porosity, permeability and pore throat size, which allows the classification of data and the quality of the reservoir based on the pore throat size [5].

DISCRETE ROCK TYPES

As FZI are continuous variables, the FZI continuous variable can be converted to a discontinuous variable using the DRT equation. In this case, the samples are classified into separate categories [6]. The average porosity and permeability results in each method for all data are shown in Table 1.

Table 1: Average porosity and permeability for total data.

	Methods of determination petrophysical rocky type					
Rock Type. No	FZI		DRT		R35	
	Avg Porosity	Avg Permeability	Avg Porosity	Avg Permeability	Avg Poros-ity	Avg Permeability
1	0.13	0.41	0.12	0.14	0.13	0.39
2	0.13	2.24	0.13	0.58	0.14	2.73
3	0.17	26.24	0.17	39.51	0.20	102.41
4	0.20	176.43	0.20	300.97	0.20	602.79
5	0.18	638.57	0.17	838.45	–	–

VELOCITY DEVIATION LOG

The velocity deviation log is an artificial log that combines the porosity log (Neutron, Density, and Sonic) [7]. In this study, based on the velocity deviation log, two types of positive and zero velocity deviation based on Density and Sonic data are calculated: (1) positive velocity deviation in Fahlian Formation due to the presence of Moldic, Interconnected vuggs and (2) Intraparticle resulting from the processes of dissolution and sedimentation. The zero velocity deviation in this formation is due to the Interparticle, Intercrystalline, and the Microporosity found inside the Mud-Facies. The zero velocity deviation in the Mid-Yamama section and positive velocity deviations are often seen in the Manifa section of this Formation.

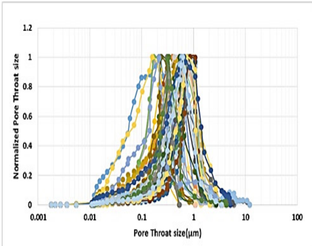
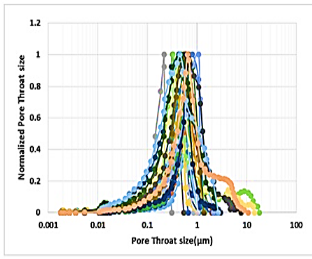
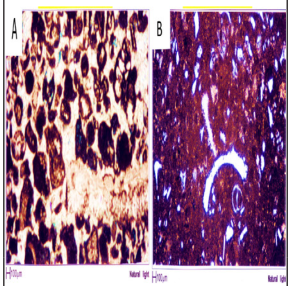
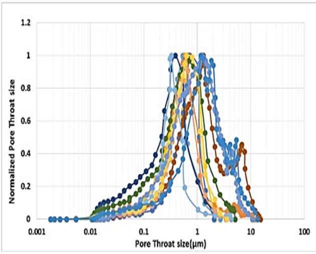
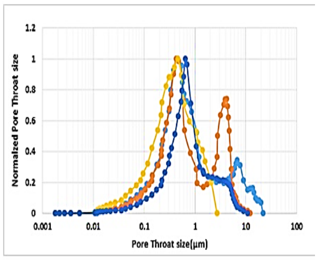
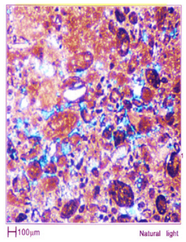
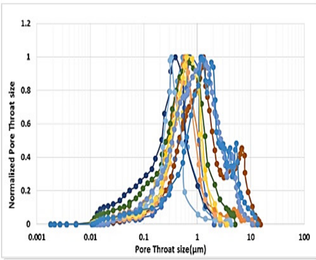
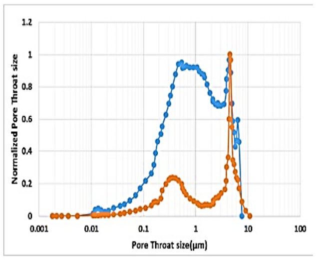
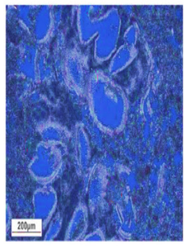
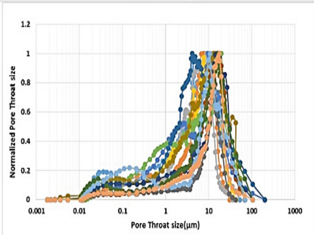
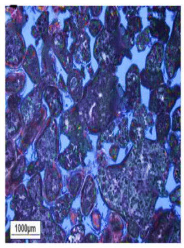
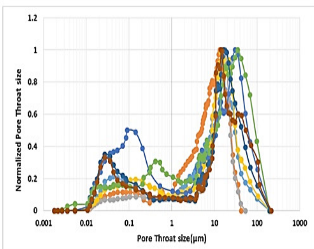
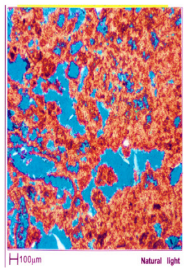
DETERMINATION OF THE DISTRIBUTION AND PORE THROAT SIZE USING THE MICP DATA

Washburne was the first person who used the mercury injection method (as a laboratory method) for estimating the pore throat size in porous rocks [8]. Dispersion the pore sizes in the rock using the mercury injection data. This distribution is presented in a graphic form, which includes the normalized pore throat size distribution versus pore throat size. These are very valuable for future studies of structural properties, pore network quality, and heterogeneity of reservoir rock, especially in carbonate rocks, because diagenesis processes can affect the mentioned cases extremely [9]. The results of the whole process are shown in Table 2.

CONCLUSION

The results of this study make the separation of five hydraulic flow units by the flow zone indicator method. Flow units 3, 4 and 5 are respectively the best flow units seen in the Manifa section. According to the velocity deviation log, the pore type in five wells of the Dorood (Fahlian Formation) is divided into six pore types, of which three types are Microporosity, Intraparticle, and Intercrystalline in the middle part of Yamama, and three type Moldic, Interconnected Vuggy Interparticle are in the Manifa section which is the best reservoir of Fahlian Formation. Moreover, pore throat size using the Washburn equation indicates an increase in the pore throat size in units 4 and 5.

Table 2: Overall results obtained from the Flow Zone Indicator Method, Velocity Deviation log and pore Throat size with thin sections.

PRT	VDL	Distribution of pore throat size in well 101P	Distribution of pore throat size in well 103WI	Thin section Photomicrographs
HFU1	Microporosity (- 400 to 400), Avg (40) Intarparticle (750 to 1500), Avg(1200			
HFU2	Interparticle (-200 to 450), Avg (250) Intercrystallin (-50 to 500), Avg (400			
HFU3	Moldic (600 to 1400), Avg (750) Intercrystalline (-50 to 500), Avg (400)			
HFU4	Interparticle (-200to 450), Avg (250)			
HFU5	Interconnected Vuggy (500-700), Avg (550)			

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